TITLE: FIELD TRIP TO A POWER PLANT - A Reading Guide

TOPIC: Energy and the sources of energy used in power plants

GRADE LEVEL: Secondary

CONTENT STANDARD: Earth and Space Science

CONTENT OBJECTIVE: For students to gain an understanding of electricity, how it is made, and what resources are used to make it. Also encourages them to think about the future of our various energy sources, and what this means to their generation.

TIME REQUIRED: 90 minutes - good to break it up

MATERIALS NEEDED: This activity relies on chapter 4 of the Student Guide "Energy Use" from the Global Systems Science interdisciplinary course for high school students from the University of California Berkeley Lawrence Hall of Science. This chapter is downloadable from the following Web site: http://www.lawrencehallofscience.org/GSS/. You will need to register (free) to receive a password to access the materials. If you have enough computers, students can simply read the text on it while answering the student pages. The book can, however, be downloaded for a small fee per student. Details can be found on the Web site.

It is strongly suggested that this activity be used after a discussion of how electricity is generated (see chapter 2 – Energy Basics- of the same Student Guide; there are activities in which students make a generator). It would help if they understand the concepts of a generator, turbine, Wattage and voltage.

Unfortunately, GSS changed this power plant chapter and have recently omitted a scintillating section on the possibility of tidal power. The teacher may wish to have the students do some research on that developing possibility and the first commercial wave-powered electric generators (see www.wavegen.co.uk). Also, fuel cell technology may increase natural gas plants up to 70% efficiency (http://www.fce.com/#).

DIRECTIONS FOR INSTRUCTION/ACTIVITY:
GSS Student Guide on **Energy Use** (last one), Chapter 4 (Field Trip to a Power Plant).
Answer key:
Part A:
1. Pacific Gas and Electric, Pittsburgh, CA
2. Seven that run on oil or natural gas. Natural gas is preferred because it burns cleaner.
3. Turbine. Steam.
4. 2000 gallons of water.
5. To prevent thermal pollution, which would disrupt the ecosystem if the hot water was put directly into the natural water system.
6. They are responsible for the safety of the equipment and the people who work on it.
7. Electric lines went down, the current stopped flowing, and the turbines sped up.
8. 10 times faster than here.
9. No!

Part B: 1. The Sun.
Fossil Fuel: 1. Coal, oil, natural gas.

Pros: Daily operating costs are low right now. They're efficient, our whole system is based on them.
Cons: Emit pollutants; mining is expensive and dangerous; oil spills; cause acid rain; non-renewable so we will run out; contribute to greenhouse gases.
2. Not good, since we are getting low in this country and will have to import more and more.
Nuclear: 1. Enriched uranium.
Pros: No pollutants or greenhouse gases; very small quantities produce large amounts of energy. Cons: Non-renewable; dangerous radioactive wastes produced; accidents, though rare, have widespread repercussions; waste ores from mines present a health hazard; plants only last 30-50 years and are expensive to decommission.
2. Not good in many nations, like U.S., but some nations depend heavily on it.
Geothermal: 1. Heat within the Earth, uranium, or radioactive decay.
Pros: Very clean; large energy source.
Cons: Unreliable, energy can deplete.
2. Future is good in certain areas if local populations allow them.
S**olar-Thermal Electric**: 1. Sunlight.
Pros: No fuel costs; clean; renewable.
Cons: Doesn't produce at night or on cloudy days, so must have a storage or backup system.
2. Future looks great if we can develop good storage systems and cheaper solar panels.
Thermo-Electric: 1. 30% efficient. 2. Not because of bad design, in fact good design keeps it as high as 30%. 3. Efficiency = $100\% \times \frac{\text{Useful Work}}{\text{Energy Used}}$
Hydroelectric: 1. The force of gravity acting on water.
Pros: Inexpensive, no fuel costs; clean; efficient (much more than thermal power plants)
Cons: Large tracts of lands submerged, ecosystems destroyed; reservoirs silt up, thus power plants last only about 50 years.
2. Do not have to heat the water – no energy is lost as heat in this manner.
3. Not good, most sites are taken .
Wind Generators: 1. Wind (ultimate source is the sun)
Pros: No fuel costs; clean;
Cons: Birds can be killed; noisy and an eyesore; intermittent, so must be linked with other energy sources or have a storage system.
2. Possibilities.
Part C: Conclusions:
1. Coal, 43.3%; Gas 19.6%; Petroleum 10%
2. 72.9%
3. Answers will vary, should indicate fossil fuels will start to drop as it will get more expensive as we have to import more; nuclear may stay same or go up?; hydro will drop as plants have to shut down; hopefully solar will increase as cheaper materials are built to make the solar panels; wind may increase since it is cheap.
4. Answers will vary.
5. $200,000,000,000 ($200 billion)

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FIELD TRIP TO A POWER PLANT - A Reading Guide

GSS STUDENT GUIDE - ENERGY USE – Chapter 4, Field Trip to a Power Plant

Part A. The visit:

1. Which power plant are we visiting and where is it?

2. How many power plants does this plant actually have, and what do they run on?

   Which fuel is preferred and why?

3. A generator is where a huge copper coil is spun between two magnets to generate electricity. What spins the generator?

   In a fossil fuel power plant, what turns the turbine?

4. How many gallons of water does the plant require to cool the steam?

5. Why is the water cooled before it is dumped back into the river?

6. What is the main responsibility of the power plant operators?

7. When demand suddenly drops, like during the earthquake in 1989, what happens?

8. How fast is demand for power expected to grow abroad?

9. Do you think fossil fuels will be able to keep supporting all that energy need?

Part B: For the following, please read each page and list the pros (good stuff) and cons (not so good stuff) of each energy source starting on page 32.

1. What is the ultimate source of energy that feeds a fossil fuel power plant (hint: it is not fossil fuel!)

FOSSIL FUEL POWER PLANT

1. What are the direct sources of energy that feed a fossil fuel power plant?

PROS: CONS:

2. What is the future of fossil fuel energy?

NUCLEAR POWER PLANTS

1. What is the source of energy that feeds a nuclear power plant?

PROS: CONS:

2. What is the future of nuclear energy?

GEOTHERMAL POWER PLANTS

1. What is the source of energy that feeds a geothermal power plant?

PROS: CONS:

2. What is the future of geothermal electric energy?

SOLAR-THERMAL ELECTRIC POWER PLANTS

1. What is the source of energy that feeds a solar-thermal electric power plant?

PROS: CONS:

2. What is the future of solar-thermal electric power?

THERMOELECTRIC POWER PLANTS: All of the power plants you have just read about are thermoelectric – they use heat to produce steam that turns the turbine of an electric generator. By having to use the heat to produce steam to do mechanical work, there is **always** a loss of energy and therefore a loss of efficiency of the system.

1. How efficient are most thermoelectric power plants?

2. Is this low efficiency because of bad design? Explain.

3. What is the equation for efficiency?

HYDROELECTRIC POWER PLANTS

1. What is the source of energy that feeds a hydroelectric power plant?

PROS: CONS:

2. Why is a hydroelectric power plant more efficient than a thermoelectric power plant?

3. What is the future of hydroelectric energy?

WIND GENERATORS

1. What is the source of energy that feeds a wind generator?

PROS: CONS:

2. What is the future of wind generated power?

PART C: CONCLUSIONS

1. According to the Energy Information Administration of the U.S. Dept. of Energy, in 1998, what are our top three energy sources and in what percentages?

2. (Question 4.14) What percent of electrical energy in this country comes from the burning of fossil fuels (all fossil fuels).

3. Based on the reading you have done, how do you think the percentages of different plants will change over the next 50 to 10 years? Why? (see this Web page article for some help: http://www.iht.com/articles/75696.html)

4. Answer question 4.15. What kinds of power plants would you recommend to a developing nation? Why?

5. What is the cost for running and maintaining the vast U.S. electrical power system?